Administrative Order on Consent Amendment Study Smelter/Tailing Soil Investigation Units

Chino Mines Company
Hurley, New Mexico

June 2006

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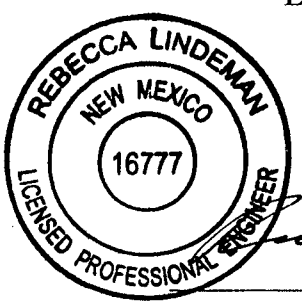
REPORT

Administrative Order on Consent Amendment Study Smelter/Tailing Soil Investigation Units

Respectfully submitted,

BLASLAND, BOUCK & LEE, INC.



Rebecca Lindeman, P.E. License #16777

Chino Mines Company
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BBL®
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

1.0 Introduction

On December 23, 1994 Chino Mines Company (Chino) and the New Mexico Environment Department (NMED) entered into an Administrative Order on Consent (AOC) to address the possible environmental impacts within the Investigation Area (IA) due to mining operations, historical releases, and natural sources. The upland Smelter and Tailing Soil Investigation Units (STSIUs) are two of the six investigation units within the IA. Copper is the contaminant of concern within the surface soil in the STSIU. (REFER TO APPROVED DOCUMENT WHICH IDENTIFIES COCs.

Based on the surface soil copper concentration data, the area of upland soil with surface soil copper concentrations greater than 5,000 mg/kg is approximately 150 acres to the east of the smelter operational area and approximately 240 acres north of Hurley (390 acres total) (Figure 1). The areas with copper concentrations greater than 5,000 mg/kg will be managed under an Interim Action Work Plan (IAWP) for excavation, to be submitted under separate cover. These areas are limited to portions of the uplands located directly downwind from the smelter and adjacent to the smelter operational area. The areas associated with bird HQ greater than two, and are the focus of this Amendment Study, are approximately 230 acres to the east of the smelter operational area and approximately 258 acres to the west and north of Hurley (Figure 1). Approximately 145 acres east of the smelter operational area are within a topographically-limiting area. Soil sampled is above the specified criteria within this Work Plan; however, the soil is located in isolated dry "pools" within a cliff band. The area is shown as hatched on Figure 1 because interim action in this cliff area will be limited to accessible and reasonably-large, open areas. As smelting activities have ceased, deposition in this area will not continue. Therefore, a targeted, but limited action in this area due to topography and nature of the deposits is reasonable.

WHAT ARE CU CONCS? ARE THEY DIFFERENT

The results of this Amendment Study will be utilized to develop an Amendment IAWP for the 230 acres to the east of Hurley and 258 acres to the west and north of Hurley. The following steps describe the path forward for the STSIU:

- implement this Amendment Study in June 2006;
- sample the amended soils during the rainy season of 2006 to ensure that the target pH has been attained;
- stabilize the soils to protect against excessive erosion and sedimentation within the disturbed areas;
- prepare the Amendment IAWP in fall 2006; and
- revegetate, as necessary, immediately prior to the 2007 rainy season in those areas where vegetation has not reestablished naturally.

Additional detail of the proposed Amendment Study and follow-on monitoring is provided in the following sections.

WHAT ARE GOALS OF THIS STUDY? - TO DETERMINE IF TILLING & AMENDING SOILS WILL REDUCE CU CONCENTRATIONS TO SECOW ?

NMED DECIDES WHAT I.A. IS ACCEPTABLE

NEXT PAGE

INTERIM MEASURE ACTION WILL IT BE PROTECTIVE ? - FUTURE USES - COMMUNITY RESPONSE

2.0 Basis of Design

The Interim Action Work Plan (IAWP) (BBL, 2005) outlined three remediation strategies based on copper concentration, bird hazard quotient, and rangeland condition to address the STSIU. The purpose of this Amendment Study is to determine the appropriate amendment, rate of application, and tilling method to address the elevated copper concentrations, for full-scale implementation for the approximately 700 acres of uplands. A ¼ acre section from four impacted areas (West of Hurley, North of Hurley, North East of Hurley [East A], and East of Hurley [East B]) will be utilized in this study. Areas, such as, North of Hurley and East A, where the bird hazard quotient is greater than 2 and vegetation is poor, will be amended, tilled, and restored as necessary. Areas West of Hurley and East B, where the bird hazard quotient is greater than 2 and vegetation is fair/good will be amended without tilling (i.e., spray amended).

2.1 Lime Amendment

Adjusting the pH is important for a number of chemical and physical effects in the soil. A pH in the range of approximately 6-7 provides for readily available plant nutrients as well as increased bacteria and actinomycetes populations. Fungi function well across a range of pH from greater than 4 to less than 9. The solubility of copper will also decrease within this range. The calcium (Ca) will eventually help to increase structure and facilitate infiltration and reduce runoff. With Na in the system, Ca will readily replace it on the exchange, which will also help to increase infiltration capacity.

Lime will applied as a slurry (oxide or hydroxide) in order to increase the application rate and minimize dust generation during application and subsequent tilling (within the two areas with poor vegetation).

The amount of lime to be used is a function of a number of factors including surface and subsurface: pH, cation exchange capacity (CEC), texture, structure, type of lime, and amount of organic matter. A soil buffer equilibration is used in lieu of specific laboratory analyses, for determination of pH (e.g. SMP, Double-Buffer SMP, Adams and Evans, etc.). These methods take into account the "reserve" acidity as a function of the CEC, as well as other acids in the soil. In the low pH areas, more than one application may be necessary to achieve a satisfactory pH level to establish revegetation.

For this Amendment Study, BBL assumes the following:

- The surface texture of the pertinent soils is dominantly sandy loam.
- The bulk density is comparable to numbers from the literature for sandy loams (e.g. ~1.6 Mg/m^3).
- The CEC is similar to other sandy loams given in the literature.
- The CEC is dominated by acid (hydronium ion).
- The lime used will have a high fineness factor and low moisture content.

To determine the best application rate, the lime application rates may be varied within each plot. Depending on soil characteristics, it is possible that up to 30 tons of lime/acre (multiple applications) may be needed to raise the pH from 2 (an extreme low) to 6.5 (a relatively high number) to allow for revegetation. As for the other areas that have a more neutral pH, liming is not generally recommended if the pH is above approximately 5.6.

In sandy soils which sometimes record lower pH values with a high SMP buffer value and where fertilizers have not been applied, light applications (1-2 T/acre) of lime generally suffices to neutralize soil acidity. BBL assumes these rates will be appropriate in more "neutral" pH areas. For this reason, BBL recommends rates of 2.0 to 2.5 T/acre in the West and North areas where pH may be close to 5.0.

In those areas where the lime will be applied as a slurry, it will be important to add the slurry in a low-intensity, longer duration application to avoid erosion and shallow subsurface movement of the slurry.

2.2 Organic Matter Amendment

Organic matter (OM)/organic carbon can serve as a buffer to soil acidity. OM in arid soils is generally low as a result of drier, oxidized conditions. Soil organic matter is also relatively small in well drained mineral soils, ranging from two to six percent by weight. Six percent is a high-end "equilibrium" number. In light sandy loams it is difficult to get soil OM up to or above four percent. For the purpose of this study, one percent of OM is assumed to be already in the soil at the site. The goal would be to raise the OM content to approximately three percent.

The are two main types of amendments for OM incorporation are solid (compost) and sludge from local municipal plants (solids and liquid). Sludge application would not be desirable since it can be high in metals.

There are approximately 2.1×10^6 lbs mineral soil per acre-furrow slice. Two percent by weight is approximately 20 tons compost per acre. The C/N ratio of the compost should be between 20:1 to 30:1. Legumes and "farm manures" have these lower ratios. Straw residues and sawdust should be avoided since their C/N ratios can range from 100:1 to 400:1 and can adversely affect plant growth if microbial populations are present in the soil. C/N ratios in the furrow-slice in arable soils range from 8:1 to 15:1 with the median between 10:1 and 12:1.

OM will be applied following lime application in each of the four amendment study areas.

2.3 Revegetation

Given the high metal concentrations, acidic soil characteristics, and extreme / punctuated moisture, temperature, and wind fluctuations on the Hurley facility (and proximate lands), plant selection is focused on "phytostabilization" and not "phytoremediation" of the heavy metal concentrations. Phytostabilization is the process in which plants are used to immobilize metals in the soil (and thus minimize their mobility in water or dust). In contrast, phytoremediation is the process in which plants are used to extract/clean up contaminants within the soil.

Although the Surface Mining Control and Reclamation Act of 1977 allows for the use of introduced/ exotic species in reclamation efforts, the importance of restoring permanent native vegetation communities is widely recognized and accepted. Reasons for this often are that native species have a long history of genetic sorting and natural selection within a local environment. These adaptations often allow native species to survive, grow, and reproduce to a greater extent than introduced species in these areas harsh environments under many environmental extremes. In addition, the restoration of native plant communities often times have positive impacts upon recolonization and/or utilization by faunal populations.

Natural revegetation by native species has been demonstrated at various locations near Hurley. Additionally, large scale seeding efforts prior to determining the success of liming applications has significant cost implications. Therefore, disturbed areas will be stabilized with erosion fabric following amendment and will be allowed to naturally revegetate over the 2006 rainy season. This timing will allow suitable time for development of favorable soil conditions and increase survival or planted species. Areas that do not achieve substantial natural revegetation by May 2007 will be seeded prior to the rainy season. Substantial revegetation is measured by erosion and sediment control achieved by plant cover within the amendment study plots.

2.3.1 Seed Selection

STUDY

There are generally two approaches to consider in the phytostabilization of areas addressed under this Work Plan. The first is an agricultural approach, where impacted areas are planted using introduced or cultivated species that have previously shown to be highly productive in similar environments and soil conditions. The second approach is an ameliorative/adaptive approach which involves amending soils in-situ, and identifying, specifying, and establishing plants that are ecotypically differentiated, or adapted to site conditions. This second approach is the preferred alternative in that it addresses biodiversity, self-sustaining plant communities, and thus wildlife habitat. A seed mixture was previously presented in the CCP that should allow for sustainable biodiversity.

BBL will perform a limited field plant survey in the areas proposed for tilling prior to implementation of soil disturbing activities. Following the 2006 rainy season and soil sampling, a second plant survey will be conducted to assess natural revegetation within the disturbed areas. Standard vegetation sampling protocols will be followed to identify species composition and cover throughout the proposed impacted areas. the second field effort is intended to identify additional native species that are able to succeed under the 'new' soil conditions (i.e., normalized pH, lower metal concentrations). As mentioned previously, disturbed areas that do not attain substantial plant regrowth will be revegetated prior to the 2007 rainy season.

IS DETERMINED BY NMED

3.0 Field Methods

The Amendment Study will be performed on the four ¼ acre plots as shown on Figure 1.

Prior to implementation and approximately 2 weeks following implementation, soil samples will be collected to determine the pH and copper bioavailability of the surface soil. Soil sampling for the East A and East B areas will be conducted after the first amendment application to determine the application rate for the second amendment application. The sampling frequency is assumed to be 8 samples per 1/4-acre plot per sampling event. Samples will be sent for offsite laboratory analysis for pH and copper availability.

West of Hurley the vegetation is good and the pH of the soil is approximately 4.5 to 5. Therefore, spray application of the amendment will be performed in this area without tilling.

North of Hurley the vegetation is poor and the soil pH is 4.5 to 5. This area will require limited clearing and grubbing followed by spray application of lime and roto-tilling the soil.

The East A area vegetation is poor and the pH is approximately 2 to 2.5. Clearing and grubbing will be required to facilitate the application of the lime slurry and additional applications will likely be necessary to achieve acceptable pH soil conditions for revegetation.

East B area will be challenging due to the slope of the area (1.5:1 or greater) and a pH ranging from 2 to 2.5. The lime application will be sprayed without tilling to minimize erosion.

Clearing and grubbing of the areas, as described above, will be performed using a bulldozer and an excavator. The soils will not be significantly moved or excavated during this process. The metal teeth on the equipment will be used only to remove the vegetation.

The following table lists the specifications for each ¼-acre amendment plot.

Area	Amendment	Application Rate (Tons/acre as CaCO3)	Application Method	OM Addition/Rate (Tons/acre)	Revegetation
West	Lime slurry	2.0 T/acre	Spray only	NA	No
North	Lime slurry	2.5 T/acre	Spray and Till	10T/acre	Yes
East A	Lime slurry	6.6 T/acre	Spray and Till	20T/acre	Yes
East B	Lime slurry	6.6 T/acre	Spray only	NA	Yes

3.1 Erosion Control and Best Management Practices

During the Amendment Study, erosion cloth will be applied upon completion of lime application to minimize erosion due to wind and rain. The fabric will be anchored using wooden or metal stakes. On steeper slopes, such as the North area and East A, fiber rolls will be installed along the slopes at

approximately 30-foot spacing along the slope. The fiber rolls will act to reduce the velocity of sheet flow down the slope and will also act to hold some moisture on the slope.

Following application of lime and OM, as necessary, tilled areas will be left with furrowed ridges to aid in moisture retention and sedimentation control. These small ridges and valleys will serve to slow sheet flow and maximize infiltration during vegetation reestablishment.

3.2 Health and Safety

The existing BBLES Health and Safety Plan, dated January 2006, will be utilized for all field activities. The level of personal protective equipment will be determined based on the hazards associated with each task. Job safety analysis's (JSAs) will be developed to support the amendment activities, as necessary.

How will the plan be revised to NMED & EPA

4.0 References

BBLES 2006. Health and Safety Plan. Revision 0. Chino Mines Company. Hurley, New Mexico. (January 2006).

BBL 2005. Administrative Order on Consent, Interim Action Work Plan, (IAWP), Smelter/Tailings Unit Investigations, Revision 2, Chino Mines Company. Hurley, New Mexico. December 2005

Arienzo, M. Adamo P., Cozzolino V. 2004. The potential of Lolium perenne for revegetation of contaminated soil from a metallurgical site. Science of the Total Environment 319 (1-3): 13-25.

Bouwman LA, Bloem J, Romkens PFAM, Boon GT, Vangronsveld J. 2001. Beneficial effects of the growth of metal tolerant grass on biological and chemical parameters in copper- and zinc contaminated sandy soils. MINERVA BIOTECNOLOGICA 13 (1): 19-26.

Daniel B. Stephens & Associates, Inc. 2000. Comprehensive Vegetation Survey of Chino Mine. Grant County, New Mexico.

Jain, SK, Bradshaw, A.D. 1966. Evolutionary divergence among adjacent plant populations. Heredity 21: 407-441.

Paschke, MW, Redente EF. 2002. Copper toxicity thresholds for important restoration grass species of the western United States. Environmental Toxicology and Chemistry 21 (12):2696-2697.

LEGEND:

- TAILING PONDS
- CITY LIMITS
- DUE TO CLIFF-LIKE TOPOGRAPHY, INTERIM ACTION WILL BE LIMITED TO OPEN AREAS
- AOC BOUNDARY
- DRAINAGE
- AMENDMENT AREAS
- APPROXIMATE UPLAND AREA WITH SOIL COPPER > 5,000 MG/KG
- APPROXIMATE UPLAND AREA WITH BIRD HQ > 2 BASED ON LOAEL 20% BIOAVAILABILITY
- SMELTER / TAILING OPERATIONAL AREA

0 1,000 2,000 Feet

GRAPHIC SCALE

5/15/06 BRI-85 TBR SYR-85 KEW PET-85 EGH
Cino Mines Company (63506.004)
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CHINO MINES COMPANY
HURLEY, NM

AMENDMENT STUDY WORK PLAN

SITE OVERVIEW

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FIGURE
1

BBL®

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